MOEJ/GEC JCM Feasibility Study (FS) 2014
Summary of the Final Report

"Introduction of Co-generation System Using Bagasse in a Sugar Factory"

(Implementing Entity: Japan NUS Co., Ltd.)

1. Overview of the Proposed JCM Project

Study partners	Tohoku Electric Power: advice on grid connection and negotiation with EVN Takuma: provide suggestion on bagasse fired boiler Shinko: provide suggestion on turbine Jpan Quality Assurance Organization (JQA): provide suggestion on developing MRV methodology Nishishiba: provide suggestion on generator JGC Vietnam: establish EPC structure and estimate project cost Nghe An Sugar Company: provide information on sugar factory and make project plan IMC: discuss financing
Project site	Nghe An Province, Vietnam
Category of project	1. Energy Industries (Renewable sources) and 13. Waste handling and disposal
Description of project	Nghe An Sugar Company (NASU), one of the largest sugar companies in Vietnam, is planning to replace boiler of the factory that has been running more than 15 years and introduce 20MW ~ 35MW co-generation system that runs with bagasse from sugar process. All vapor from the system is consumed for sugar process. 6MW of electricity generated is used for internal process and the rest is to be sold to EVN (VietNam Electricity). GHG emissions reduction is achieved by substituting grid electricity by electricity from biomass.

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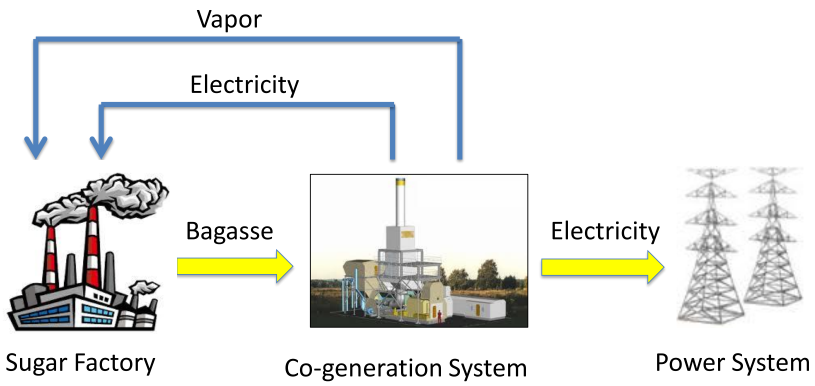
<tr><td></td><td colspan="4">
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<tr><td rowspan="2">Expected project implementer</td><td>Japan</td><td colspan="3">JGC Corporation</td></tr>
<tr><td>Host country</td><td colspan="3">Nghe An Sugar Company (NASU)</td></tr>
<tr><td>Initial investment</td><td colspan="2">50,000,000 USD</td><td>Date of groundbreaking</td><td>2016</td></tr>
<tr><td>Annual maintenance cost</td><td colspan="2">100,000 USD</td><td>Construction period</td><td>18 month</td></tr>
<tr><td>Willingness to investment</td><td colspan="2">Investment by NASU</td><td>Date of project commencement</td><td>2018</td></tr>
<tr><td>Financial plan of project</td><td colspan="4">Finance is under discussion with several financial institutions including IFC.</td></tr>
<tr><td>GHG emission reductions</td><td colspan="4">144,751 (tCO2/year)</td></tr>
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2. Study Contents

(1) Project development and implementation

1) Project planning

This project is for introducing high-pressure boiler that uses the whole amount of bagasse discharged from the plant and to introduce a cogeneration system to supply steam and generate electric power for the plant in accordance with the renewal of the boiler equipment of the plant. The scale of power generation is estimated between 20 MW to 35 MW in which about 6 MW is used within the plant and the rest will be sold to EVN. The capacity of existing bagasse power generation equipment is 10 MW that has been operating since 1997. During the operation period of the plant (November to April), the power demand of the plant of about 6 MW is covered mainly by the bagasse power generation equipment and the auxiliary by a diesel power generator. The receiving voltage from the existing electric power system is 10 kV in which the electricity is used not for the plant but as light-load power source used in the office, dormitory, etc. during periods when plant is not operating. The amount of bagasse (strained lees of sugarcane) combusted by the boiler for supplying steam is about 30% of the total emissions. Most of remaining bagasse is supplied for a fee to a farm owned by the parent company TH Milk as a bed material for cows.

Project implementation structure is shown as below (figure 1). The parent company of NASU is TH Milk, a major food company in Vietnam. IMC (Investment Management Company) in TH Milk will decide the implementation of this program. IMC is the company specifically in charge of managing funds for investment business of the TH Milk Group.

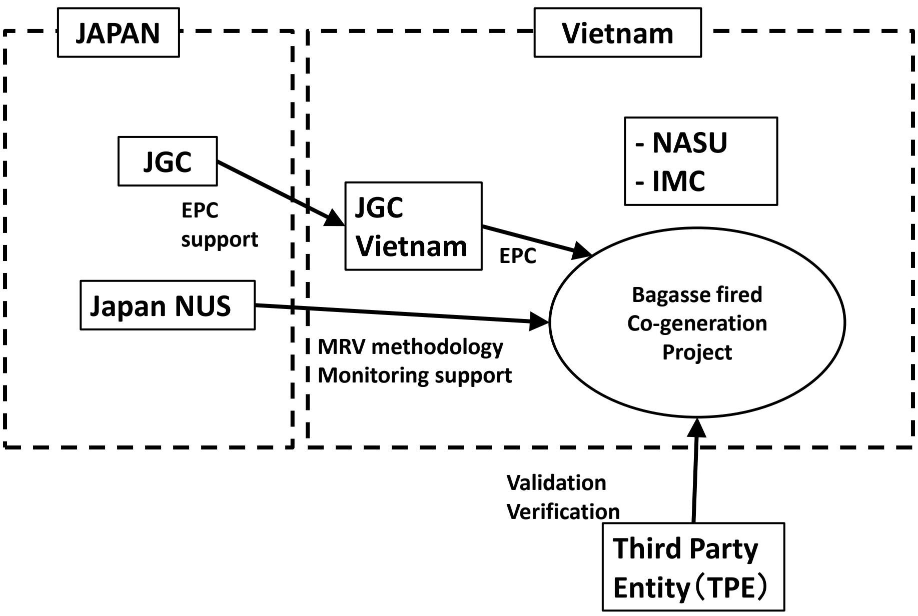

Figure 1: Project implementation structure

The construction plan will be prepared by JGC Vietnam, the EPC contractor, and the construction period is estimated at around 18 months.

As for economical evaluation, three patterns were examined, namely; (i) Implementing without equipment assistance from JCM, (ii) Only equipment (boiler, turbine, and power generator) assisted by JCM, and (iii) Equipment and construction cost assisted by JCM (Table 1). Project IRR of 15 years of the case (i) is 12%, which seems not to be attractive enough. If the project was decided to implement without using JCM support, there will be higher possibility of adopting one or all facilities of the boiler, turbine and/or power generator manufactured in India or China in order to increase economic efficiency.

Table 1 Results of examination of economical evaluation

	(i) Implement without equipment support of JCM	(ii) Only equipment supported by JCM	(iii) Equipment and construction cost supported by JCM
Equipment grant amount			
Project IRR (10 years)	3%	9%	16%
Project IRR (15 years)	12%	16%	22%
Investment payback period	7.9 years	6.0 years	5.3 years

The investment policy places importance in leverage in which the capital is 30% and loan is 70% in principle. Various options including domestic and overseas banks are examined for loan. IFC (International Finance Corporation), who is already initiating discussion with IMC, is taking a positive stand for loaning. Therefore, it is assumed that the amount of loan estimated for this project can be obtained.

2) Permits and License for the project development and implementation

Main licensing procedures required to implement the project are procedures for connection of transmission system and sales contract in which it is assumed to be proceeded by the procedure as follows; (1) Transmission system information check, (2) Prior consultation, (3) Request of connection examination, (4) Basic agreement, (5) Contract.

(1) Transmission system information check

It is necessary to conduct a hearing with EVN to identify the estimated transmission system connection point, etc. when the plan concept is decided before examining details of the project since construction of new access equipment for selling electricity is planned in this project. There is a high possibility that the connection of transmission system of this project will be interconnected to 110 kV. If the voltage class and position of the power transmission line listed as a candidate for the contact point can be confirmed at this phase, devices (transformer, circuit breaker, etc.) necessary as access equipment can be estimated and task to select an area to install the transformer substation can be proceeded. In addition, if the number of channels can be identified, auxiliary channels can be examined and risks in selling electricity can be examined in case the power transmission line is shutdown.

(2) Prior consultation

It is necessary to request a detailed technical examination to the electric utility when requesting a reply of the possibility of connecting transmission system at the final phase to the electric utility. As prior phase of requesting examination of connection, it is necessary to confirm with the electric utility the presence of interconnection limit evaluated by capacity, direct distance between the power generation equipment installation area and desired connection point for laying the access power transmission line, and the party bearing responsibility of laying the access power transmission line.

(3) Request of connection examination

Detailed technical examination by EVN is required to receive information of possibility to connect transmission system and of conditions for selling electricity from EVN. The examination covers items described below.

(4) Basic agreement

Although negotiating of purchasing price is unnecessary by FIT, approaches will be conducted to negotiate the construction of access equipment in the basic agreement of the electric power sales contract.

(5) Contract

Contract procedure status of the feed-in tariff (FIT) system will be judged after the basic specification is decided and economic evaluations that are detailed to a certain extent are conducted.

Although this project is a project to generate electricity, environmental impact assessment is not included as a regulatory procedure since it is installed in the site of NASU plant.

3) Advantage of Japanese technology

About 40 sugar manufacturing plants in Vietnam are either joint venture with a foreign firm or state-owned enterprises. All boiler equipment used at these sugar manufacturing plants is manufactured in China excluding plants of joint ventures with foreign firms and one large state-owned enterprise. Boilers introduced at joint ventures and the large state-owned enterprise are manufactured in Australia, India and Republic of South Africa. NASU is using the boiler manufactured by ABB Australia as well.

Complete replacement of the 10MW BTG (Boiler-Turbine-Generator) system operating from initiating of the plant to equipment manufactured in Japan is considered in this project. Introduction of turbine of Takuma Co., Ltd. as well as turbine by Shinko Ind., Ltd. and power generator by Nishishiba Electric Co., Ltd. is planned by request of NASU.

As for competing products of the high-temperature high-pressure boiler (pressure: 105 bars and temperature: 520°C) proposed by Takuma, there are high-temperature high-pressure boiler (pressure: 125 bars and temperature: 545°C) manufactured in China and a boiler for cogeneration using bagasse (pressure: 67 bars to 110 bars and temperature: approx. 470°C to 500°C) manufactured in India.

Current products installed by Japanese manufacturer such as turbine of Shinko and power generator of Nishishiba have the high reliability of the products based on the fact that the products including the shredder turbine have never malfunctioned since the initiation of the operation at the plant. In general, the sugar manufacturing plant has to gain profit by concentrating the operation only during five months. Malfunction during the sugar manufacturing can be critical and therefore, the reliability of the equipment is the utmost importance for the plant. The largest issue of Japanese products against competitive products manufactured in India and China is the high price. It is often said that products manufactured in Japan is estimated at around 1.5 to 2 times higher in price than that manufactured in India and China. It is difficult to use original numeric standard for the turbine and power generator used for cogeneration system since types and specifications are decided after deciding the boiler specification.

4) MRV structure

System as shown in Table 2 is assumed at present as the system to implement MRV in this project. The project owner NASU measures and records the system operation data where Japan NUS (JANUS) checks and records the basic unit of electric power system as well as prepares and submits the monitoring report. After monitoring performed for a certain amount of time, TPE (third party entity) verifies the emission reduction amount based on the monitoring report submitted by JANUS.

Table 2 MRV implementation system

	Content	Implementing party
Monitoring	Monitor and record the cogeneration system operation data	NASU
	Check and record the basic unit of electric power system	JANUS
Reporting	Preparation of monitoring report	JANUS
	Submission of monitoring report	JANUS
Verification	Verification of emission reduction amount	TPE (third party entity)

There are three parameters in scope of monitoring in this project based on the proposed MRV methodology. Three parameters are; annual electric power supply output (EG_y) to external system by the installed cogeneration system using bagasse, consumption amount ($FC_{i,y}$) of fossil fuels (igniting agent) used when starting the bagasse combustion boiler, and CO_2 emission factor (EF_{grid}) of the electric power system supplying the electric power in the project.

Monitoring structure is considered as below (Figure 2).

Figure 2 Monitoring structure

5) Environmental integrity and Sustainable development in host country

This project uses bagasse, waste generated in sugar manufacturing process, as fuel. Use of bagasse contributes to decreasing of air pollutant such as nitrogen oxide and sulfur oxide considering the component of sugarcane. Furthermore, although carbon monoxide and suspended particulate matter may be generated at incomplete combustion, generation of incomplete combustion is not assumed since bagasse is combusted by single fuel combustion boiler with appropriate environmental measures in existing equipment.

In addition, as indirect environmental impact in implementing the business, excessive bagasse from the sugar manufacturing plant is conventionally used as the bed in cowsheds for dairy cattle owned by TH Milk, the parent company of NASU, in which it is later used as compost. However, when bagasse used in cowsheds of TH Milk is supplied to cogeneration equipment by implementation of this project, woodchip will most likely be used as substitute of bagasse. Although various types of woodchips are available and are produced in various countries, there is a possibility that they are produced in a method that inhibits forest conservation and biodiversity conservation causing concerns of indirectly but negatively affecting the environment. Attention is required in the selection of woodchip by TH Milk when implementing this project.

6) Toward project realization (planned schedule and possible obstacles to be overcome)

In December 2014, agreement between stakeholders was made in terms of this project as described below.

- Start preparation to apply for JCM PS investigation in FY2015.

- Complete the engineering within FY2015 and initiate construction in FY2016 as scheduled in the initial plan.
- NASU and TH Milk Group will finance the project and no external investor is permitted to enter.

Consultation with NASU/IMC as well as IFC of the World Bank Group was held in December for financing where IFC showed high interest in provision of finance to this project and agreed to exchange further information.

As for the schedule in the future, first, application to JCM PS will be made in FY2015, contents of work and person in charge will be assigned by the end of January 2015 among three companies of NASU, JGC Vietnam and JANUS for initiating pre-engineering of the project, work will be started in February 2015, and the completion is aimed in April. Along with this work, consultations with PECC1, a subsidiary of EVN and a consulting company for electric businesses, are held regarding connection of transmission system to EVN. Issue is the short term left until initiation of public offering of JCM PS investigation of the next fiscal year. Information obtained at pre-engineering is essential for applying to JCM PS. We will address our efforts to have smooth communication with persons concerned to complete the investigation as fast as possible.

(2) JCM methodology development

1) Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

Criterion 1	The bagasse used as fuel by the project shall be a waste from the sugar factory which is the project site. It shall not include municipal wastes or the other wastes. Fossil fuels can be used as an ignition accelerator and the amount of them is lower than 5% of the bagasse on the basis of calorific value.
Criterion 2	The project includes the installation of new co-generation system, capacity expansion of existing co-generation system, and/or replacement of existing co-generation system. If the project site has an existing co-generation system, the project must expand the capacity of power generation more than the original capacity.
Criterion 3	The bagasse used as fuel by the project shall not be stored for more than a year in order to avoid the fermentation of bagasse under anaerobic conditions and the succeeding release of methane gases.
Criterion 4	The project must not only supply electricity and heat to the sugar factory, but also provide most of electricity generated by the project to the grid.
Criterion 5	The pressure of steam from the boiler installed by the project to combust bagasse shall be 10 MPa or more. The temperature of that shall be 520℃ or more.

2) Calculation of GHG emissions (including reference and project emissions)

Estimated use of fossil fuel in this project to introduce cogeneration using bagasse in Vietnam is the ignition agent used to help ignition when starting the bagasse combustion boiler. Amount of emission of greenhouse effect gas using this ignition agent is calculated as described below.

$$PE_y = \sum_i FC_{i,y} * EF_{Fuel,i,y}$$

$FC_{i,y}$ = The quantity of fuel type i combusted as a firework fuel in year y (mass or volume unit/year)
$EF_{Fuel,i,y}$ = CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)
i = Fuel types combusted as a firework fuel in year y

$EF_{Fuel,I,y}$ which is the CO_2 emission coefficient of fossil fuel used as the ignition agent is expressed in the equation described below.

$$EF_{Fuel,i,y} = NCV_{i,y} * EF_{CO2,i,y}$$

$NCV_{i,y}$ = The weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,i,y}$ = The weighted average CO_2 emission factor of fuel type i in year y (tCO_2/GJ)
i = Fuel types combusted as a firework fuel in year y

Use of heavy oil as the ignition agent and annual usage of 3 t is assumed. Values of “The 2006 IPCC Guidelines on National GHG Inventories”, the guideline provided by IPCC, are referred for the net calorific value ($NCV_{i,y}$) of heavy oil and CO_2 emission coefficient ($EF_{CO2,j,y}$). According to this guideline, the net calorific value of heavy oil is 41.7 TJ/Gg (residual fuel oil, upper value) and the CO_2 emission coefficient of heavy oil is 78,800 kg-CO_2/TJ (residual fuel oil, upper value). Therefore, the CO_2 emission coefficient of heavy oil used as ignition agent is calculated as described below.

$$
\begin{aligned}
EF_{Fuel,i,y} &= NCV_{i,y} \times EF_{CO2,i,y} \\
&= 41.7\ (TJ/Gg) \times 78{,}800\ (kg\text{-}CO_2/TJ) \\
&= 41.7\ (TJ/1{,}000{,}000kg) \times 78{,}800\ (kg\text{-}CO_2/TJ) \\
&= 3.28596\ (kg\text{-}CO_2/kg)
\end{aligned}
$$

Since the annual usage of ignition agent is 3 t ($FC_{i,y}$), the CO_2 emission is calculated as described below.

$$
\begin{aligned}
PE_y &= FC_{i,y} \times EF_{Fuel,I,y} \\
&= 3{,}000\ (kg) \times 3.28596\ (kg\text{-}CO_2/kg) \\
&= 9857.88\ (kg\text{-}CO_2)
\end{aligned}
$$

Therefore, the annual emission (PE_y) by this project is 10 tCO_2.
The amount of reduction of greenhouse effect gas by this project is calculated by the difference between the reference emission amount and the project emission amount since this is a project to introduce cogeneration equipment using bagasse in a sugar manufacturing plant where leakage will not occur due to the activity.

Annual GHG emission reduction = Reference emission - Project emission

$= 144{,}761 \ (tCO_2) – 10 \ (tCO_2)$
$= 144{,}751 \ (tCO_2)$

The amount of reduction of greenhouse gas emission is estimated as 144,751 tCO_2/year by this project according to the calculation based on the proposed MRV methodology.

3) Data and parameters fixed *ex ante*

There are five parameters necessary for calculation of GHG emission reduction amount according to the proposed draft of MRV methodology. Those parameters are; electric energy supplied to the transmission system among electricity generated by the cogeneration system introduced by the project, basic unit of CO_2 emission of electricity of the transmission system supplied by the electricity generation, consumption amount of fossil fuel used as firework fuel, net calorific value of the fossil fuel, and CO_2 emission coefficient of the fossil fuel.

The amount of electricity supplied to the transmission system by electricity generation of the introduced cogeneration is measured by 24-hour monitoring. Furthermore, crosscheck of documents is possible when a power generation operator in Vietnam is selling electricity to a transmission system since payment is made according to the invoice sent from the operator to EVN, the state-owned enterprise, who is managing the system.

The latest version of the "Study, definition of Vietnam grid emission factor" published by the Department of meteorology, Hydrology and Climate Change, MONRE and Ozone Layer Protection Centre, a government ministry of Vietnam, is referred to for the basic unit of CO_2 emission of the transmission system electricity in Vietnam. The latest version at present is the value of FY2011.
The consumption amount of fossil fuel used as an ignition agent will be recorded in the same manner as electric energy by monitoring.

The value of relevant fossil fuel is to be quoted from the IPCC default values at the upper limit of uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vo.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories proposed by the Intergovernmental Panel on Climate Change (IPCC) for the net calorific value of fossil fuel used as an ignition agent. In addition, CO_2 emission coefficient of the ignition agent is to be quoted from the IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vo.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.

Examination of the appropriateness of using the basic unit of CO_2 emission of system electricity in Vietnam published for CDM and use of net calorific value of fossil fuel and CO_2 emission coefficient published by IPCC for calculation of emission reduction amount by the project is required as future tasks.